

WHAT IS CLAIMED IS:

1. An undercoating material for lithography, said material being for forming an undercoating layer on a semiconductor substrate before formation of a photoresist layer for wiring formation patterning on the substrate, said material comprising:

a resin component having at least a substituent group which is capable of releasing a terminal group to form a sulfonic acid residue upon application of predetermined energy, and

a solvent.

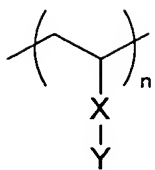
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2. An undercoating material for silicon bilayer process, said material being for forming an undercoating layer of a lithographic silicon bilayer process for accurately forming a wiring layer on a substrate, said material comprising:

- 15 a resin component having at least a substituent group which is capable of releasing a terminal group to form a sulfonic acid residue upon application of predetermined energy, and

a solvent.

- 20 3. The undercoating material for silicon bilayer process according to claim 2, wherein the resin component has at least a repeating unit represented by the following formula (1):



... (1)

wherein n is an integer of 1 or more, X represents a C1 to C10 linear or branched alkyl chain, an aromatic or alicyclic alkyl chain or an alkyl ester chain, and Y is a substituent group which is capable of forming a sulfonic acid residue upon application of the predetermined energy.

4. The undercoating material for silicon bilayer process according to claim 2, wherein the predetermined energy applied for generating the sulfonic acid residue is light and/or heat.

5. The undercoating material for silicon bilayer process according to claim 3, wherein the substituent group Y in the formula (1) is $-\text{SO}_3\text{R}_1$ or $-\text{SO}_3^-\text{R}_2^+$ whereupon R_1 and R_2 each represent a monovalent organic group.

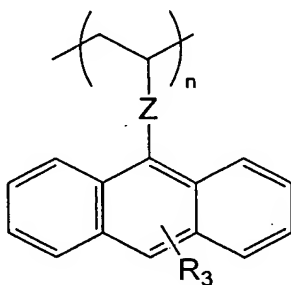
6. The undercoating material for silicon bilayer process according to claim 5, wherein the organic group R_1 is one member selected from the group consisting of a C1 to C10 alkyl group and hydroxyalkyl group.

7. The undercoating material for silicon bilayer process according to claim 5, wherein the organic group R_2 is at least one member selected from the group consisting of alkanolamine and alkylamine.

8. The undercoating material for silicon bilayer process according to claim 2, wherein the resin component having at least a substituent group which is capable of releasing the terminal group to form the sulfonic acid residue upon application of predetermined energy is a copolymer of the resin
5 component described in claim 4, and acrylic acid or methacrylic acid or a derivative thereof, or a mixed resin thereof.

9. The undercoating material for silicon bilayer process according to claim 2, wherein the resin component having at least a substituent group
10 which is capable of releasing the terminal group to form the sulfonic acid residue upon application of predetermined energy is a resin component consisting of:

a copolymer produced by copolymerization of the polymer or the mixed resin of the resin component described in claim 4 and acrylic acid or
15 methacrylic acid or a derivative thereof, with a repeating unit represented by the following formula (2):



... (2)

20 wherein n is an integer of 1 or more, R₃ is at least one member selected from the group consisting of a hydrogen atom, a fluorine atom, a hydroxyl group, a

carboxyl group, a C1 to C5 hydroxyalkyl group and a C1 to C5 alkoxyalkyl group, and Z represents a C1 to C10 linear or branched alkyl chain, an aromatic or alicyclic alkyl chain or alkyl ester chain; or

- 5 a mixed resin of the copolymer or the mixed resin of the resin component described in claim 4 and acrylic acid or methacrylic acid or a derivative thereof, together with a resin compound having the repeating unit represented by formula (2).

- 10 10. The undercoating material for silicon bilayer process according to claim 2, which further comprises a crosslinking agent.

11. A wiring formation method comprising:
an undercoating layer forming step of forming an undercoating layer using the undercoating material for silicon bilayer process according to claim 15 2;
a upper resist pattern forming step of forming an upper photoresist layer using a silicon-containing photoresist material on the undercoating layer and subjecting the upper photoresist layer to exposure and development treatment, to form a predetermined resist pattern;
20 an undercoating pattern forming step of removing, by dry etching, an exposed portion of the undercoating layer which is not covered with the upper photoresist pattern;
a wiring pattern forming step of etching the substrate using the upper resist pattern and the patterned undercoating layer as a mask, to form a
25 predetermined wiring pattern; and

a resist pattern removing step of removing, with a resist stripping solution, both the undercoating layer pattern and the upper resist pattern remaining on the substrate at the same time after formation of the wiring pattern.

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12. The wiring formation method according to claim 11, wherein the resist stripping solution used in the undercoating resist pattern forming step comprises at least one member selected from the group consisting of a water-soluble amine and quaternary ammonium hydroxide.

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13. The wiring formation method according to claim 12, wherein the water-soluble amine is at least one member selected from alkanolamine and alkylamine.

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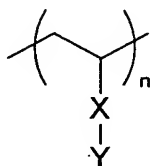
14. An undercoating material for multilayer process, said material being for forming a multilayer having at least an undercoating layer, an intermediate layer and a photoresist upper layer as a final resist pattern for accurately forming a wiring layer on a substrate, said material comprising:

a resin component having at least a substituent group which is capable of releasing a terminal group to form a sulfonic acid group upon application of predetermined energy, and
a solvent.

15. The undercoating material for multilayer process according to claim 14, wherein the resin component has at least a repeating unit represented by the

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following formula (1):



... (1)

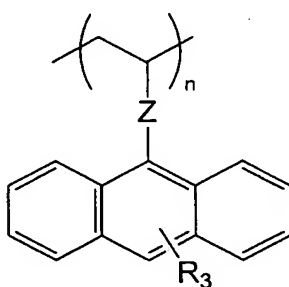
- 5 wherein n is an integer of 1 or more, X represents a C1 to C10 linear or branched alkyl chain, an aromatic or alicyclic alkyl chain or an alkyl ester chain, and Y is a substituent group which is capable of forming a sulfonic acid residue upon application of predetermined energy.
- 10 16. The undercoating material for multilayer process according to claim 14, wherein the predetermined energy applied for generating the sulfonic acid residue is heat of not less than 80°C.
- 15 17. The undercoating material for multilayer process according to claim 15, wherein the substituent group Y in the formula (1) is $-\text{SO}_3\text{R}_1$ or $-\text{SO}_3^-\text{R}_2^+$ whereupon R_1 and R_2 each represent a monovalent organic group.
- 20 18. The undercoating material for multilayer process according to claim 17, wherein the organic group R_1 is one member selected from the group consisting of a C1 to C10 alkyl group and hydroxyalkyl group.
19. The undercoating material for multilayer process according to claim 17, wherein the organic group R_2 is at least one member selected from the group

consisting of alkanolamine and alkylamine.

20. The undercoating material for multilayer process according to claim 14,
wherein the resin component having at least a substituent group which is
5 capable of releasing the terminal group to form the sulfonic acid residue upon
application of predetermined energy is a copolymer of the resin component
described in claim 17 and acrylic acid or methacrylic acid or a derivative
thereof, or a mixed resin thereof.

10 21. The undercoating material for multilayer process according to claim 14,
wherein the resin component having at least a substituent group which is
capable of releasing the terminal group to form the sulfonic acid residue upon
application of predetermined energy is a resin component consisting of:

a copolymer produced by copolymerization of the polymer or the
15 mixed resin of the resin component described in claim 17 and acrylic acid or
methacrylic acid or a derivative thereof, with a repeating unit represented by
the following formula (2):



... (2)

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wherein n is an integer of 1 or more, R₃ is at least one member selected from

the group consisting of a hydrogen atom, a fluorine atom, a hydroxyl group, a carboxyl group, a C1 to C5 hydroxyalkyl group and a C1 to C5 alkoxyalkyl group, and Z represents a C1 to C10 linear or branched alkyl chain, an aromatic or alicyclic alkyl chain or alkyl ester chain; or

5 a mixed resin of the copolymer or the mixed resin of the resin component described in claim 17 and acrylic acid or methacrylic acid or a derivative thereof, together with a resin compound having the repeating unit represented by the formula (2).

10 22. The undercoating material for multilayer process according to claim 14, which further comprises a crosslinking agent.

23. A wiring formation method comprising:

 an undercoating layer forming step of forming an undercoating layer
15 using the undercoating material for multilayer process according to claim 14 on a substrate;

 an intermediate layer forming step of forming an intermediate resist layer using a silicon oxide film material on the undercoating layer;

 an upper resist pattern forming step of forming an upper photoresist
20 layer on the intermediate layer and subjecting the upper photoresist layer to exposure and development treatment, to form a predetermined resist pattern;

 an intermediate layer pattern forming step of removing, by dry etching, an exposed portion of the intermediate layer which is not covered with the upper resist pattern;

25 an undercoating layer pattern forming step of removing, by dry etching,

an exposed portion of the undercoating layer which is not covered with the intermediate layer pattern as a mask;

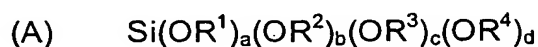
a wiring pattern forming step of etching an interlaminar insulating layer on the substrate with the undercoating layer pattern as a mask to form a
5 predetermined wiring pattern; and

an undercoating pattern removing step of removing, with a resist stripping solution, the undercoating layer pattern remaining on the substrate after formation of the wiring pattern.

10 24. The wiring formation method according to claim 23, wherein the resist stripping solution used in the undercoating pattern forming step comprises at least one member selected from the group consisting of a water-soluble amine and quaternary ammonium hydroxide.

15 25. The wiring formation method according to claim 24, wherein the water-soluble amine is at least one member selected from alkanolamine and alkylamine.

20 26. The wiring formation method according to claim 23, wherein the silicon oxide film material for forming the intermediate layer makes use of a material obtained by hydrolyzing at least one compound selected from spin-on-glass materials represented by the following formulae:



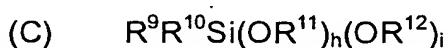
wherein R^1 , R^2 , R^3 , and R^4 independently represent a C1 to C4 alkyl group or
25 a phenyl group, and each of a, b, c, and d is an integer satisfying the following

relationships: $0 \leq a \leq 4$; $0 \leq b \leq 4$; $0 \leq c \leq 4$; $0 \leq d \leq 4$; and $a + b + c + d = 4$,



wherein R^5 represents a hydrogen atom or a C1 to C4 alkyl group, R^6 , R^7 , and R^8 each represent a C1 to C3 alkyl group or a phenyl group, and each of e , f ,

5 and g is an integer satisfying the following relationships: $0 \leq e \leq 3$; $0 \leq f \leq 3$; $0 \leq g \leq 3$; and $e + f + g = 3$,



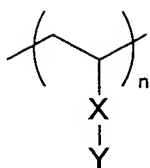
wherein R^9 and R^{10} each represent a hydrogen atom or a C1 to C4 alkyl group, R^{11} and R^{12} each represent a C1 to C3 alkyl group or a phenyl group, and

10 each of h and i is an integer satisfying the following relationships: $0 \leq h \leq 2$; $0 \leq i \leq 2$; and $h + i = 2$.

27. A filler material for filling an etching space for forming a dual damascene structure composed at least of a first etching space formed in a low-dielectric layer on a substrate and a second etching space communicating with the first etching space and different in shape and dimension to those of the first etching space, said material comprising:

a resin component having at least a substituent group which is capable of releasing a terminal group to form a sulfonic acid residue upon application of predetermined energy, and a solvent.

28. The filler material for forming the dual damascene structure according to claim 27, wherein the resin component has at least a repeating unit represented by the following formula (1):



... (1)

wherein n is an integer of 1 or more, X represents a C1 to C10 linear or
 5 branched alkyl chain, an aromatic or alicyclic alkyl chain or an alkyl ester
 chain, and Y is a substituent group which is capable of forming a sulfonic acid
 residue upon application of the predetermined energy.

29. The filler material for forming the dual damascene structure according
 10 to claim 27, wherein the predetermined energy applied for generating the
 sulfonic acid residue is heat of not less than 80°C.

30. The filler material for forming the dual damascene structure according
 to claim 28, wherein the substituent group Y in the formula (1) is $\text{---SO}_3\text{R}_1$ or
 15 $\text{---SO}_3^-\text{R}_2^+$ whereupon R_1 and R_2 each represent a monovalent organic group.

31. The filler material for forming the dual damascene structure according
 to claim 30, wherein the organic group R_1 is one member selected from the
 group consisting of a C1 to C10 alkyl group and hydroxyalkyl group.

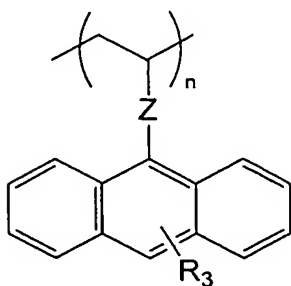
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32. The filler material for forming the dual damascene structure according
 to claim 30, wherein the organic group R_2 is at least one member selected
 from the group consisting of alkanolamine and alkylamine.

33. The filler material for forming the dual damascene structure according to claim 27, wherein the resin component having at least a substituent group which is capable of releasing the terminal group to form the sulfonic acid residue upon application of predetermined energy is a copolymer of the resin component described in claim 30, and acrylic acid or methacrylic acid or a derivative thereof, or a mixed resin thereof.

34. The filler material for forming the dual damascene structure according to claim 27, wherein the resin component having at least a substituent group which is capable of releasing the terminal group to form the sulfonic acid residue upon application of predetermined energy is a resin component consisting of:

a copolymer produced by copolymerization of the polymer or the mixed resin of the resin component described in claim 30 and acrylic acid or methacrylic acid or a derivative thereof, with a repeating unit represented by the following formula (2):



... (2)

wherein n is an integer of 1 or more, R₃ is at least one member selected from the group consisting of a hydrogen atom, a fluorine atom, a hydroxyl group, a carboxyl group, a C1 to C5 hydroxyalkyl group and a C1 to C5 alkoxyalkyl group, and Z represents a C1 to C10 linear or branched alkyl chain, an
5 aromatic or alicyclic alkyl chain or alkyl ester chain; or

a mixed resin of the copolymer or the mixed resin of the resin component described in claim 30 and acrylic acid or methacrylic acid or a derivative thereof, together with a resin compound having the repeating unit represented by formula (2).

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35. The filler material for forming the dual damascene structure according to claim 27, which further comprises a crosslinking agent.

36. A method of forming a dual damascene structure, comprising:

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an interlaminar insulating layer forming step of laminating an interlaminar insulating layer including at least a low-dielectric layer, on a substrate having a metal layer;

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a first etching space forming step of forming a photoresist layer on the interlaminar insulating layer and subjecting the photoresist layer to patterned exposure and development treatment, to form a photoresist pattern, and performing etching using the photoresist pattern as a mask to form a first etching space in the interlaminar insulating layer;

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an embedding step of applying the filler material of claim 27 onto the interlaminar insulating layer thereby forming an embedded material layer and simultaneously charging the embedded material into the first etching space,

a photoresist pattern forming step of forming a photoresist layer on the embedded material layer, and subjecting the the photoresist layer to patterned exposure and developing it with a 2.38 wt% tetrametyl ammonium hydroxide developing solution to form a photoresist pattern,

5 a second etching space forming step of performing etching using the photoresist pattern as a mask to remove the interlaminar insulating layer on the first etching space in a predetermined pattern to form a second etching space communicating with the first etching space; and

an embedded material removing step of removing, with a stripping
10 solution, the embedded material remaining in the second etching space.

37. The method of forming the dual damascene structure according to claim 36, which further comprises a step of forming an anti reflective coating film on the embedded material layer on the interlaminar insulating layer after
15 the embedding step, and a step of processing, by dry etching, an exposed portion of the anti reflective coating film using the photoresist pattern as the mask after the photoresist pattern formation step.

38. The method of forming the dual damascene structure according to
20 claim 36, wherein the stripping solution used in the embedded material removing step comprises at least one member selected from the group consisting of a water-soluble amine and quaternary ammonium hydroxide.

39. The method of forming the dual damascene structure according to
25 claim 38, wherein the water-soluble amine is at least one member selected

from alkanolamine and alkylamine.